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AN MIS FRAMEWORK FOR ANALYZING THE ORGANIZATIONAL IMPACT OF MANAGEMENT INFORMATION SYSTEMS PROJECTS

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THESIS

AN MIS FRAMEWORK FOR ANALYZING
THE ORGANIZATIONAL IMPACT OF
MANAGEMENT INFORMATION SYSTEMS PROJECTS

by

Dennis J. Egan

June 1981

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An MIS Framework for Analyzing the Organizational Impact of Management Information Systems Projects

by

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Submitted in partial fullfillment of the
requirements for the degree of

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ABSTRACT

The U.S. Navy's Shipboard Non-tactical ADP Program (SNAP II) is a proposed shipboard management information system (MIS). By first building a basic MIS framework using a simple organizational information system model and developing certain general measures of an MIS project's impact, the SNAP II project is analyzed. The framework allows the investigation of MIS impact at specific organizational levels. The effect of unevenly distributed impact at specific levels can be significant with regard to the overall value of the MIS. This impact might not be anticipated by analysis of the MIS project through the use of total organizational impact alone. The analysis of the SNAP II project reveals two areas of concern. First, the SNAP II system is not a true independent shipboard MIS. Second, there are potentially detrimental undisplaced impacts, focused at the lower levels of the shipboard organization, which may result from implementation of SNAP II.

TABLE OF CONTENTS

Page

LIST OF FIGURES

I. INTRODUCTION

We are in the midst of an information revolution. More information is available to more people in less time with less effort than ever before in history. The advances of modern technology, especially in computers and communications, have already reached a point where there is a surfeit of information available. As a result, the most difficult task faced by a potential information user is deciding which information is of greatest value.

This information surplus effects not only individuals but entire organizations. The speed with which information can be collected, processed and transmitted has presented organizations with a significant challenge in efficiently managing the flow of information into and out of the organization. Systems for regulating or directing the information flow can take many forms. In the past 25 years, the use of the processing, storing and retrieval powers of modern computer equipment has become an intrinsic part of the efforts to control information systems as well as the prime cause for the explosive growth of the systems themselves.

The term management information system (MIS) has come to represent a formal effort to deal with the vagaries of an organization information system. What is a management information system? In a 1970 survey [Ref. 1: p. 16], approximately

half of those surveyed classified MIS as a 'thing' while the other half considered it a process or philosophy. Many different definitions have been proposed. In general, they are similar to the following description:

> "a management information system is defined as the formal configuration of human and capital resources and programs in an organization that results in collecting, encoding, storing, processing, retrieving, communicating, decoding, and using data for management decisions and control." [Ref. 1: p. 16]

While not necessarily involving the use of any type of computer facility, the general usage of the MIS term implies a computer based information system.

A study of MIS can be made from starting points in many disciplines. The computer basis of many MIS often results in the topic being approached as a subset of computer science. Others view the subject from a management or behavioral science perspective. One thing does seem clear. Any investigation which concentrates on one dimension of the MIS topic, in isolation, is certain to have neglected many important aspects of management information systems study.

The inherent connection between information systems and computers may result in part from the fact that much of the recent research in the field of MIS has come in response to efforts to implement a computer based MIS or significantly modify an existing automated information system. Successful completion of such a project requires a thorough understanding of the basic organization, the current information system structure and the present and future information needs of

the organization. Such a detailed understanding is dictated by the significant long term organizational investment required by many MIS projects.

While it is not wise to view aspects of MIS in isolation, it is also difficult and unwise to attempt an all encompassing approach to MIS without having a framework within which to structure and relate the results of the investigation. This thesis will attempt to develop a general MIS framework which can be used as a template for more specific investigation of particular MIS applications. In Section II, the basic structure of this framework will be explained in terms of a simple organizational information system model. In Section III, more specific aspects of the MIS framework will be developed involving certain general measures with which to analyze the potential organizational impact of an MIS project. In Section IV, an actual MIS project proposed for implementation by the U.S. Navy will be discussed using the MIS framework as a basis for analysis.

II. BUILDING THE MIS FRAMEWORK

In any discussion of management information systems and organizational considerations dealing with MIS design and implementation, it is convenient to utilize a general framework for management information systems. In attempting to establish such a framework, an adaptation of Robert Anthony's organizational planning and control framework [Ref. 2] will be utilized.

A. ANTHONY'S ORGANIZATIONAL FRAMEWORK

Within the broad area of planning and control, Anthony describes three activities: strategic planning, management control, operational control. John Zachman presents a fine tabular summary of Anthony's framework which is partially reproduced as Figure 1 [Ref. 3: p. 35] .

Anthony emphasizes several key points concerning his framework. Strategic planning involves organizational objectives and the formulation of policies designed to accomplish these objectives. Management control is concerned with obtaining and effectively using the resources necessary to accomplish the organizational objectives. Operational control is the "process of assuring that specific tasks are carried out ..." [Ref. 2: p. 18] .

Anthony recognizes the importance of information within his organizational framework. He refers generally to the

CHARACTERISTIC	STRATEGIC PLANNING	MANAGEMENT CONTROL	OPERATIONAL CONTROL
Focus of plans	one aspect at a time	whole organization	single task or transaction
Judgement	highly judgemental	relatively much - subjective decisions	relatively little - reliance on rules
Degree of structure	unstructured & irregular - each problem different	rhythmic - prescribed proceedures	repetitious
Nature of information	tailormade for problem - more external & predictive less accurate	integrated - more internal & historical- more more accurate	tailormade to operation - precise often in real time
Planning & control	planning dominant some control	emphasis on both	emphasis on control
Time horizon	tends to be long	weeks,months, years	day to day

COMPARISON OF THE THREE LEVELS OF PLANNING AND CONTROL

Figure 1

role of "information handling" in all the activities he describes. "Information handling is the process of collecting, manipulating, and transmitting information, whatever its use is to be." [Ref. 2: p. 21].

Anthony and others who have used his work make a strong point concerning the degree of precision in the organizational classifications. "The lines between the categories are blurred..." [Ref. 2: p. 20]. Other authors refer to the classification scheme as a continuum with the transition between the three classifications being gradual and overlapping.

Within the context of this discussion, two aspects of an MIS adaptation of Anthony's framework will be utilized. The first considers Anthony's view of information handling to provide a general classification of types of handling activity. The second concept involves a descriptive view of the input and output of information at the three organizational levels.

B. INFORMATION HANDLING ACTIVITIES IN THE ORGANIZATION

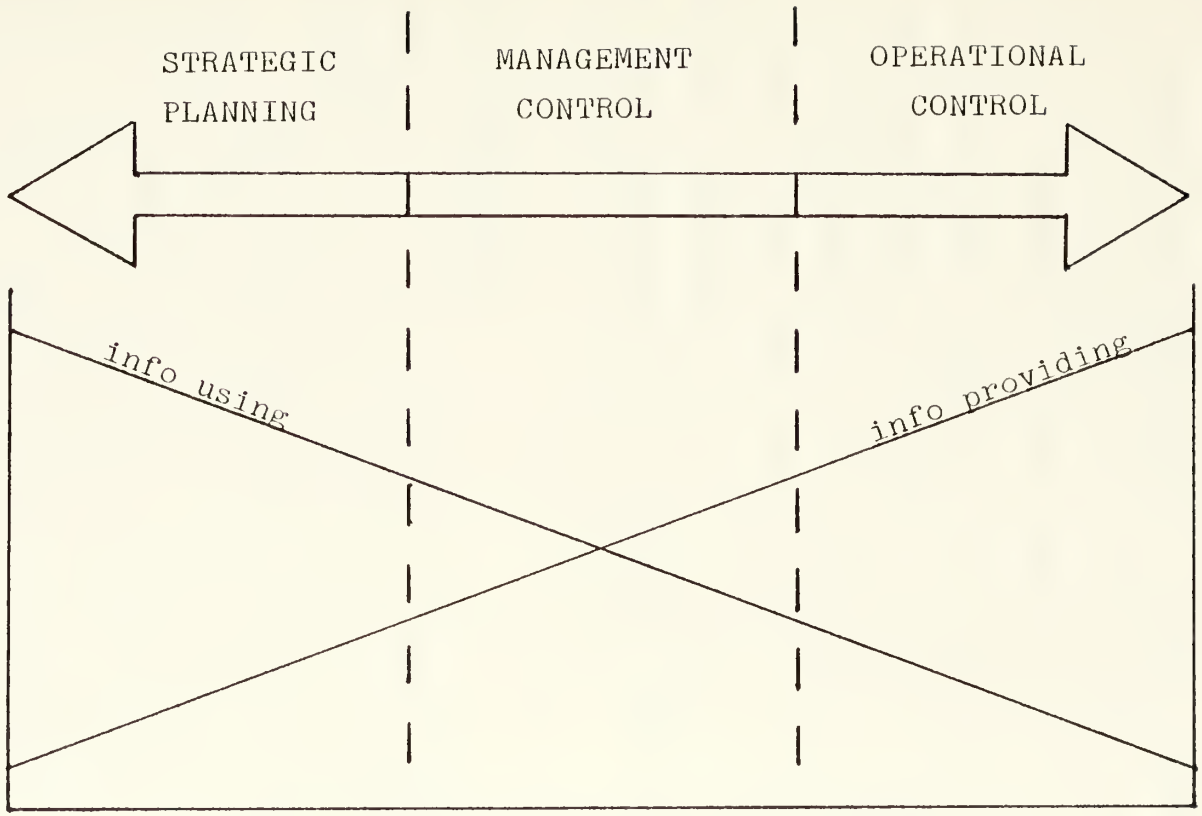
In the very simplest sense, information handling involves two different activities - information providing and information using. There may be some concern at this point that the distinction between data and information, that some authors use, should be clarified. Information is a subjectively ordered collection of data and the qualitative aspects of this ordering is not important to this discussion.

Which information handling activities prevail within the various organizational levels? It would appear that the poles

of the continuum, strategic planning and operational control provide some intuitive choices of information handling activity type. Strategic planning can be initially visualized as primarily an information user while much of the activity within the operational control level involves information providing activities.

It is difficult to characterize the information handling activity which corresponds to the management control level. In fact, there is, in this area, a significant overlap of the two basic information handling activities. Figure 2 illustrates this activity overlap within the management control level. This corresponds to Anthony's description of the overlap of planning and control activities within this organizational level [Ref. 2: p. 19]. The information handling activity within the management control level shall be referred to as information transformation for reasons that will be subsequently developed.

These information transformation activities can be considered as providing a link between the two poles of the organizational continuum. Information providing activities at the operational control level involve specific task oriented processes. Within this level, it is difficult to perceive the relational structure of the overall organization information resource. On the other hand, information using activities at the strategic planning level are involved in less structured situations which utilize highly aggregated sections of the information resource.



INFORMATION HANDLING ACTIVITY OVERLAP

Figure 2

At this level, there may be little knowledge of, or concern for the specific processes involved in maintaining the information resource. To aid in this linking role, the transformation activity, it would seem, needs to be bipolar in its focus. The central position occupied by the management control level requires this bipolarity. In the information providing flow, from the operational control level to the strategic planning level, information is both input by and output to the mangement control level. This one way information flow is, however, incomplete and it is at this point that the second aspect of the MIS framework becomes important. The hierarchical framework which Anthony describes and which is being used in this discussion, requires a flow of information in both directions along the organizational continuum. What is the type of information which moves in each direction?

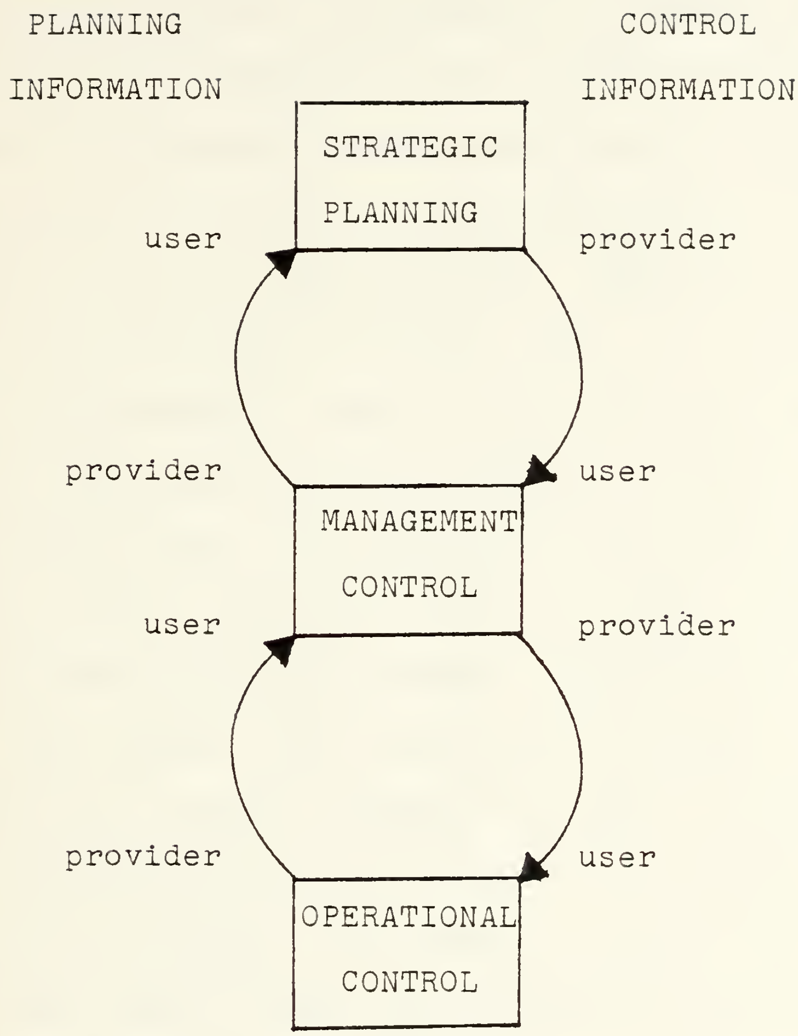
C. TYPES OF INFORMATION

Previously, the initial information providing activity was associated with the operational control level of an organization. This information passed through the management control level to the strategic planning level, the ultimate user. From the direction of this information flow between the organization levels and the nature of the functional activity performed by the end user, it is not difficult to conceptualize this information flow as being in support of the planning function of the organization. The information being communicated in this way will be classified as planning information. In

this planning information flow, the management control level uses information provided from below and provides information to higher levels.

The exercise of control can be viewed as an information providing process. In this regard, the flow of control information is a downward vector in relation to the organizational hierarchy. Thus, the strategic planning level becomes a control information provider for the management control level which, in turn, becomes a provider for the operational control level. Using the control information flow, management and operational control can then be classified as control information users. Figure 3 illustrates the complete description of organizational information flow.

The unique position of the mangement control level is emphasized in Figure 3. Russell Ackoff, in an oft quoted article, lists the two most important functions of an information system as filtration (or evaluation) and condensation [Ref. 4: p. B-148]. The management control level has a primary functional responsiblity for both these activities. In the planning information flow, information generated by the transaction based activity of the operational control level, is combined, structured and selectively manipulated by management control activity. More importantly, it is at his level that the value of the organizational information resource, as an entity, is first recognized. Accounting reports, investment summaries, inventory level reports, etc. are typical of



ORGANIZATIONAL INFORMATION FLOW

Figure 3

of the types of output of a management information system at the management control level. This type of information handling lends itself readily to computer based MIS and is consistent with the accounting focus of many computer based MIS applications.

The nature of control information is somewhat different. From the strategic planning level, control information may take the form of organization policy and objective statements or general guidance concerning levels of organizational resources which are or will be made available. This control information is used by the management control level. The general or summary information provided by the strategic planning level must be expanded, structured and efficiently disseminated to the operational control level. The control information output of the management control level can take many forms. Changes to operating standards or procedures, specific skill inventory levels, unit budgets, cost accounting standards and more are examples of the control information output at this level. Some of this information does lend itself to a computer based MIS in the area of specific task support systems, while some affects task support items such as manuals, directives or even production equipment configuration.

It may be useful to view the flow of information, both planning and control, as a stream of light with the management control level acting as a prism. For the planning information flow, the rays of the spectrum of light enter the management control prism as an upward vector using the structure shown in

Figure 3. The stream of light is coalesced by the prism into a focused beam. In the opposite direction, an aggregated beam from above the management control prism, is refracted into various component beams. This analyogy may provide some understanding of the choice of information transformation as the descriptive term for the information handling activity at the management control level.

III. EXPANDING THE MIS FRAMEWORK

> "There is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage than the creation of a new system. For the initiation has the enmity of all who would profit by the preservation of the old system and lukewarm defenders in those who would gain by the new one".
>
> Machiavelli "The Prince" 1513

Machiavelli's perception of the difficulties involved with implementing change has application to many activities including MIS. The design and implementation of a computer-based MIS can be conveniently examined by viewing such a project as a change or intervention. Many changes are involved, the most basic being the necessity for an organization to recognize organizational information as a resource and view it in relation to all organizational activities. By doing this at the initiation of an MIS project, an organization may, for the first time, examine in depth the internal structure and functions of the organization, its subunits and its total information needs. The quality of such an examination initially points the way to either success or failure of the project.

The analysis of success or failure of MIS projects is also a useful tool in the overall study of information systems. There exists a still gowing body of evidence, from such case studies which indicates a failure on the part of MIS designers to consider the complete spectrum of organizational considerations

when formulating and implementing an MIS project. The impact of this failure affects two general areas: organization structural relationships and the individual organizational user.

In Section II, examples of the types of information handling activities and flows, applicable to various organizational levels, were discussed. A further examination of the activities at each level, as potential targets for computerization, will facilitate the subsequent discussion in this section. A complete understanding of the type of tasks performed at each level provides a basis for evaluating the degree of support which can be provided by a new system and indicates any required modification to the activity processes needed to take advantage of system computerization.

It is interesting to note, in light of the discussion in Section II concerning the poles of the organization hierarchy, that the operational control and strategic planning levels of the organization provide the clearest delineation between types of functions to be supported by a new system.

A. OPERATIONAL CONTROL LEVEL

The task oriented, well-defined processes within the operational control level, provide an attractive and relatively straightforward target for computerized support within an overall MIS structure. This move to automated task support systems is often made to take advantage of what are seen to be significant realizable cost savings. These savings accrue

from the more efficient use of scarce, high cost resources, especially personnel.

Most tasks at this level involve procedures of a routine and repetitive nature. Simon characterizes this type of task, in a decision context, as a programmed decision [Ref. 5]. Keen and Scott Morton prefer the term structured task or decision [Ref. 6: p. 86] . Whatever the terminology, the essential point remains. The task process is well defined, variation limits have been historicaly refined and task support requirements are thought to be known and obtainable.

The benefits anticipated from implementation of a task support system can be viewed within the context of exercising control. As discussed in Section II, one aspect of control was considered to be an information handling activity which involved the provision of control information to the operational control level. In a computerized task support system, a significant amount of this control information can be "hard-wired" into the specific task activity support. Exercise of control may take the form of automatic error trapping at point of entry, step by step prompting, monitoring of data entry or production productivity rates and others. A computerized system allows supervisory levels to establish, modify and monitor levels of performance and productivity and compare them to those desired.

Many of the perceived organizational benefits anticipated from implementation of an MIS relate to the maintenance of a

high quality information resource. In general, the quality of this resource will significantly affect many of the information handling activities at other levels of the organization. The activities within the operational control level provide the primary substance of the information resource.

B. STRATEGIC PLANNING LEVEL

The broad information needs of the strategic planning level provide an excellent application for the significant computational and retrieval capability of a modern, computer-based MIS, given the existence of a well-structured and maintained organizational information resource. A computerized MIS can provide accurate information in a convenient, customized and sufficiently timely manner to support strategic planning level activities. Given the unstructured or, at best, semi-structured nature of activity at this level, a computerized MIS is a more general support tool. The MIS functions supporting activity at this level have none of the specific detailed task orientation that was previously seen in operational control level task support systems. In fact, flexibility of performance is a key factor in MIS support at this level. While information handling activities at the strategic planning level may have some commonality, there is a need for the capability to customize certain aspects of general MIS support capabilities on an as-needed or extended use basis. Fewer individuals will interact with the MIS at this level. However, the nature of their tasks allows the introduction of a significant amount of

individuality in the decision making process. The MIS must be adaptable for use by these individuals.

The MIS provides a varying degree of the total information handling support for the strategic planning level. An MIS provides access to an internal information resource. Activities at the strategic level often involve additional use of external information. As a result, the benefit gained from the computerized MIS at this level pertains more to the convenience and ease of access to the internal information resource rather than to the specific content of the internal information [Ref. 7: p. 7]. Whether the information end user interacts directly with the system or uses staff surrogates, the convenience benefit still pertains. Regardless of the mode of interaction, use of the MIS at the strategic planning level requires little change to the existing functional activities of that level.

C. MANAGEMENT CONTROL LEVEL

Once again, when the discussion turns to the management control level, the unique and multi-faceted information handling activities within this level become apparent. In Section II, the information handling activity at this level was described as information transformation. A computerized MIS can provide significant benefit to this organization level. In the planning information flow (Figure 3), the structuring and linking of various aspects of the information resource can be greatly facilitated by some of the tools and techniques provided by a computerized facility.

Many of the benefits derived from the implementation of task support systems within the operational control level accrue more directly to the management control level. The increased accuracy, timeliness and scope of the information resource results in the availability of a higher quality of information to the management control level and eventually to the strategic planning level in the planning information flow structure. Thus the quality of information benefit, derived initially from the operational control level task support features, has application to the two organizational levels which are the primary users of the information resource.

In the control information structure, there is also benefit to be derived by the management control level through a computerized MIS. The benefit results from the transformation of generalized control information received by management control and the provision of specific, transformed control information to the operational control level. Much of the control information received by management control is in the form of ratios describing various large scale measures of organization performance. Such things as desired return on investment, market share, cost growth ceilings, anticipated capital growth and others, can be overlayed onto historical performance data in order to determine future or desired performance parameters. A computerized MIS and its associated information processing tools provides a greatly increased capacity to apply these ratios to the structured information resource and thereby

derive specific control parameters for individual functional activities which will support the overall organization objectives. This transformed control information can also provide a convenient measure against which to gauge actual performance. This type of measure is necessary for the specific activities within the management control level concerned with resource utilization and for those activities at this level which provide planning information support for the strategic planning level.

The benefits which accure to the management control level may require a level of change, perhaps significant, in the activity processes within this level. Interaction with the physical aspects of the computerized MIS is unavoidable and can be on a frequent and repetitive basis. There are, however, aspects of information transformation activity which do not involve direct system interaction, for example, analysis of data supplied by an initial information retrieval.

D. COST AND BENEFIT ANALYSIS OF AN MIS PROJECT

The previous discussion has focused in large part on the potential benefit to be gained, at each organization level, from computerization of the organization information system. The cost variable must also be considered in an organization's analysis of the efficacy of a proposed system. When analyzing an MIS project, many cost factors are easily quantifiable. Such things as hardware, software, physical plant alterations, support utilities and revised levels of personnel are easily

transformed into actual dollar costs, some with time discounting and others as lump amounts. After quantification of these 'hard' costs, there remains a variety of cost factors which are as difficult to identify as they are to quantify. These intangible or 'soft' costs involve impact effects resulting from the change inherent in the implmementation of a computerized MIS. Many authors have attempted to deal with this aspect of organizational intervention but few, if any, have offered specific recommendations beyond the level of emphasizing the need to recognize the existence and importance of these soft costs.

One attempt to systematize consideration of all aspects of organizational impact associated with MIS is often referred to as the Socio-technical Systems approach (STS) [Ref. 8]. This methodology involves the recognition of two general subsystems within an organization - the technical system and the social system. The technical system involves the organizational processes, tasks and general technology. Much of the technical system pertains to the more easily quantifiable variables of a cost/benefit analysis. The social system pertains to the attributes of people, their interrelationship, reward systems and authority structures. Identification and quantification of this type of variable in a cost/benefit analysis can provide the greatest challenge in the design and implementation of a computerized MIS.

Even if certain soft costs are recognized, quanitification remains a problem. This discussion will not deal with the quantification issue. Resolution of this issue is often organizationally dependent and has to do with valuing both the organization's information resources and the desired level of organizational social system stability in relation to its effect on functional acitivity.

There remains, however, an aspect of cost/benefit analysis which would appear to be an important consideration in decisions effecting an MIS project, yet is rarely touched on by MIS investigators. This area is best termed cost/benefit equilibrium. It has to do with the stratification of costs and benefits within individual organizational levels.

1. Cost/Benefit Equilibrium

Whether formally or informally, analytically of implicitly, MIS users will evaluate a new system based on their perception of its impact on their functional activities. "... it is not the absolute value ... that is important but rather the way ... (the system is) ... perceived by the potential users." [Ref. 9: p. 8] Many authors recognize this fact but go on to state that a negative evaluation by a user will result in decreased usage of the MIS facilities by the disgruntled individuals. This assumes that there is an alternative to using the formal information system. In many applications, this is not the case. In fact, it may be that the lack of an acceptable alternative is a prime cause of user

dissatisfaction. The computer-based facility provides the only reasonable long term access to the organization information resource. To provide for individual access to organization information resource, outside the formal MIS procedures, would negate many of the perceived benefits of implementing a computer-based facility.

The user's position, in the organization structure, also has significant impact on his ability to withdraw from interaction with the MIS. At the strategic planning level, users can, to some extent, withdraw from direct interaction with the formal information system. Some investigators consider the delegation of interaction to staff surrogates as an example of non-use of the MIS. While it is still important to deal with the dissatisfaction of this user, this is not a useful example of negative user reaction. Complete abandonment of any use of the MIS by individuals at this level would be the most illustrative user reaction. In the previous discussion, it was seen that the activities at the strategic planning level involve both internal and external information handling. Depending on the specific activity involved, voluntary abandonment of access to the internal information resource may be a viable short term alternative for a specific user. It is difficult, however, to consider complete isolation from the formal MIS as an attractive or suitable long run alternative to MIS interaction for most users.

At the other organizational levels, the lack of suitable alternatives to MIS use is even more acute. Forced interaction due to requirements of higher organizational levels is most often the case.

Discounting abandonment, users can react in other ways to a system which fails their personal evaluation. Inappropriate behavior with regard to MIS functions is a possible response. Increased errors, both intentional or unintentional, incomplete data entry, attempts to cause system interruption are all activities which may result from an adverse perception of an MIS. Less direct effects of the imposition of a poorly considered MIS project have recently received some investigative attention. Personal stress, loss of self-esteem, increased turnover rates and reduction in productivity are all effects with probable causal relation to interaction with a computerized MIS which is not well received by users.

This type of reaction could result from an imbalance of costs and benefits within an individual organizational level. It is valid to assume that the overall cost/benefit analysis of the MIS project produced favorable results if a decision to proceed with the project was made. It would be ideal if there were a benefit excess situation at each organizational level. It is unlikely, however, that even a reasoned and well-intentioned approach to the identification and quantification of organizational social system variables, attempts an individual organization level comparison of costs and benefits. Yet this type of comparison could yield valuable information.

A typical analysis might, for example, offset costs incurred at the operational control level by benefits which accrue to the management control or strategic planning levels. It is convenient to assume an altruistic attitude on the part of the organizational workforce. That is to say, operational control personnel are sufficiently compensated for their incurred costs by the knowledge that this impact is offset by a net gain to the overall organization. Such an assumption, however, would be naive and potentially disasterous. The inappropriate behavior mentioned previously, may result from the presence of undisplaced costs within a single organizational level.

What is needed is some attempt to maintain at least a cost/benefit equilibrium within each organization level. Overall benefit excess situations are desirable and it is not intended that benefits be reduced merely to achieve an equilibrium situation. The cost excess situation is the area to which some attention must be focused.

2. Dealing with Cost Excess Situations

Within the MIS framework developed in Section II, there exists the potential for cost excess situations. Some description of the general nature of activities within each organization level was provided in previous discussion in this section. The dollar quantifiable costs involved in an MIS project are difficult to link to a specific level unless resources committed to the project were directly charged on a pro-rated

basis to individual operating budgets. For an organization wide MIS such a charge back scheme would be unusual, although one might be able to identify level specific opportunity costs which would result from a decision to proceed with an organization wide MIS project. When dealing with the soft impacts of such a project, however, it is easier to identify where certain costs and benefits specifically apply within an organization.

In terms of a socio-technical approach, soft impacts involve changes in the quality of work life (QWL). Changes in the work functions and environment will determine the new QWL. An overall lowering of the QWL, from previous levels, would indicate a cost excess condition just as a benefit excess woudl result in a net increase in the QWL. Previous discussion made some implications that a cost excess condition is most likely at the operational control level. The task support systems prevalent at this level can require significant changes in the level's social system. A task support system can be designed to control or direct much of the human operators' activity. Personal interaction between operators, an important factor in QWL determination, is often redirected to interaction with a terminal or to operator interaction via a terminal. Even direct supervisors can be required to monitor performance by means of machine interaction rather than through personal contact. At least one recent labor dispute involved, in part, the contention that human engineering of

CRT terminals and workstations had not recognized many of the effects continual use of such terminals can have [Ref. 10: p. 1].

What do personnel involved with task support systems gain from the interaction with these system? Very little direct or indirect benefit can be identified. Even the most enlightened MIS designers might only be able to foster the perception of increased operator QWL through contrivances such as reclassification of job description (i.e., clerk to data entry technican) or some job preparation training which includes a level of self-esteem reinforcement. While these are acceptable devices for a system designer to employ, they appear to be somewhat cynical in their approach. It is doubtful that efforts such as these could overcome the significant QWL decrease which would result from a poorly designed system.

Figure 4 illustrates an example of an overall organization cost/benefit equilibrium situation which still exhibits a cost excess in certain areas. This figure does not attempt to show a dollar replacement equilibrium but rather the relative levels of soft impact variables mentioned previously. Figure 5 shows how, even in an overall benefit excess condition, a cost excess situation can still exist. Likewise, Figure 6 shows an overall cost excess condition with an area of benefit excess. It is possible to imagine that even in the situation illustrated by Figure 6, a decision to proceed with an MIS project could be made since the perception of the MIS project

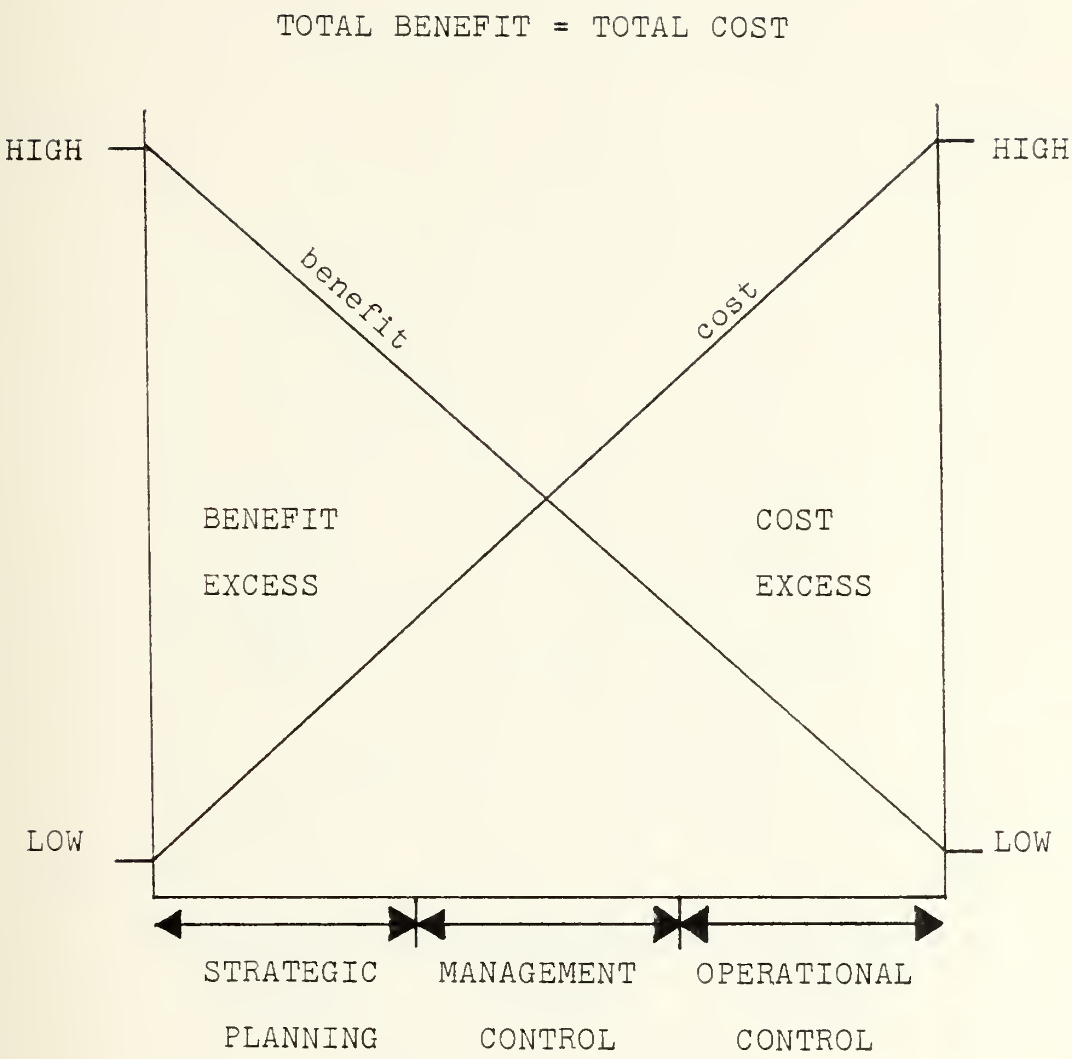
by those making this decision might be biased by a locally focused benefit excess situation.

3. Manipulating Cost/Benefit Levels

Figure 4 can be used to graphically illustrate various approaches to dealing with a cost excess situation. If the right side of the benefit line were moved upward, holding the left side generally in place, the cost excess is reduced by an overall increase in derived benefit as shown in Figure 7. It may be possible to increase the derived benefit line only within the specific organizational level desired, resulting in a kinked benefit line as shown in Figure 8.

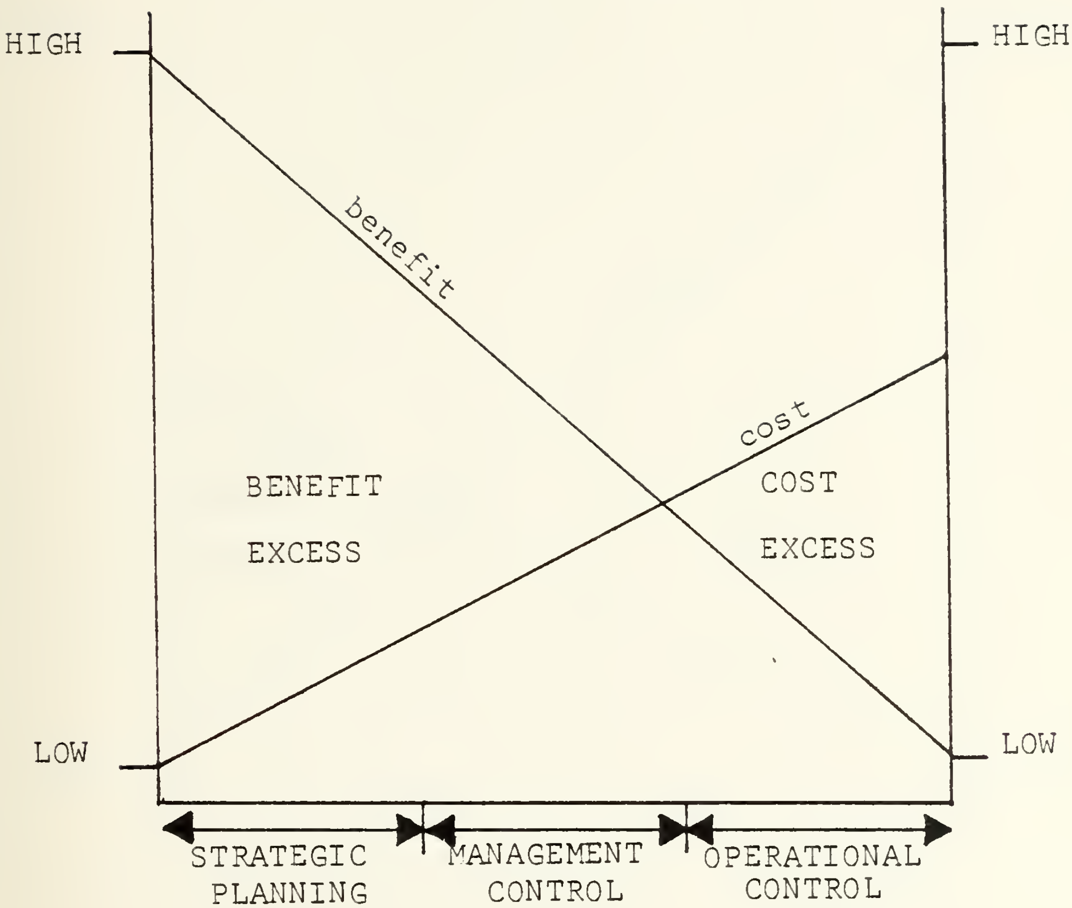
It is more likely, however, that any increase in benefit, even if directed at a specific level, will result in some benefit increase at cther levels of the organization. For example, actions which increased derived benefits at the operational control level may result in a high quality information resource which, in turn, will result in some benefit increase at other organization levels.

The complimentary approach to increasing benefit is to decrease cost. Reduction of the overall cost and reduction of cost within specific levels is possible with similar graphic results as shown in the benefit increase examples. However, it is a possiblity that by reducing costs, of the type being discussed, certain elements of the system which contribute to the level of derived benefit may be affected. This would be especially true if the action to reduce costs resulted in a less capable overall system.



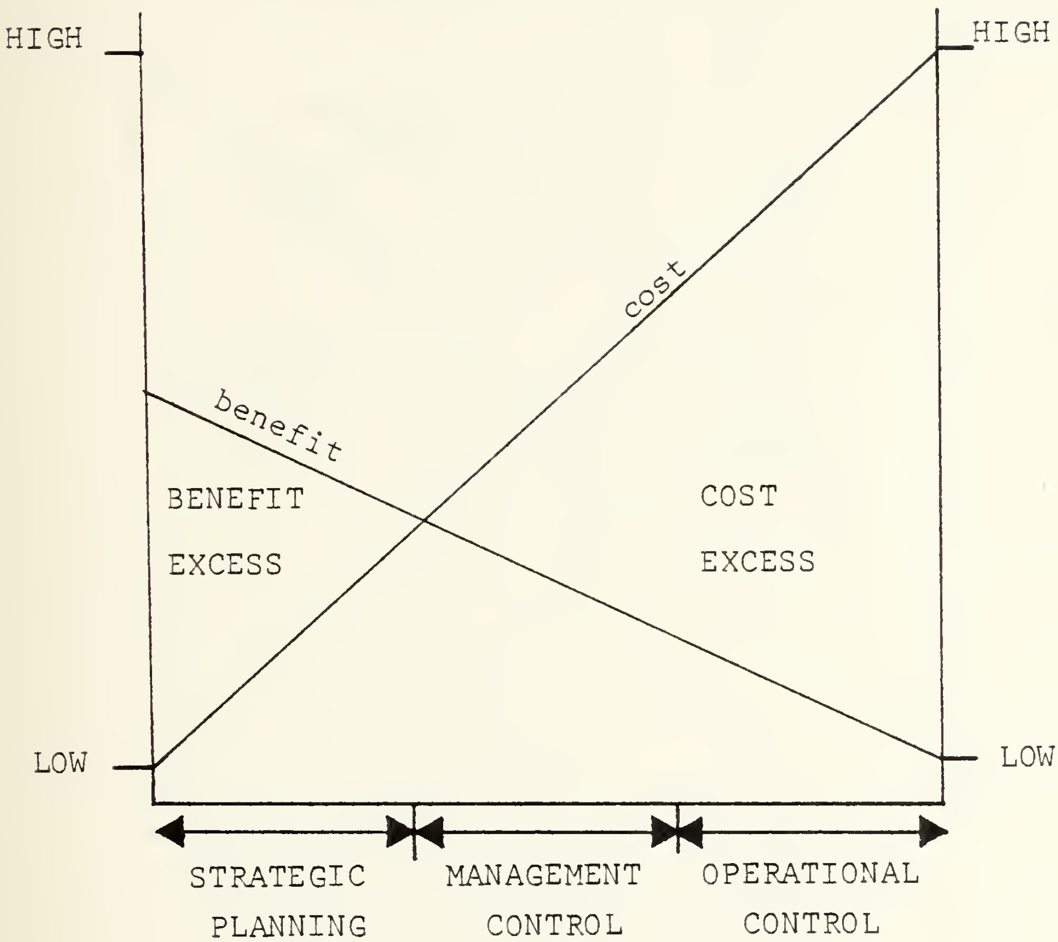
TOTAL COST/BENEFIT EQUILIBRIUM

Figure 4



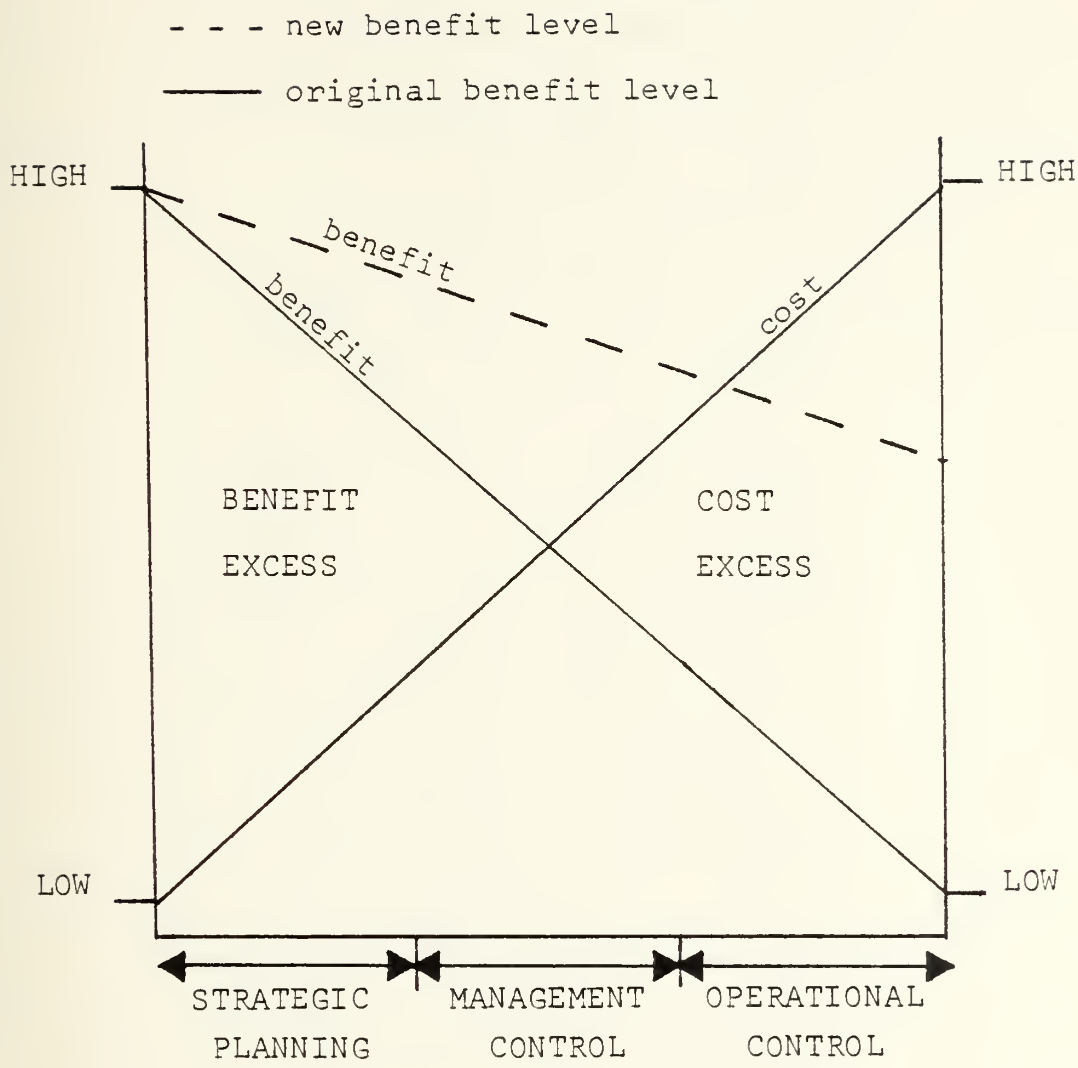
TOTAL BENEFIT EXCESS

Figure 5



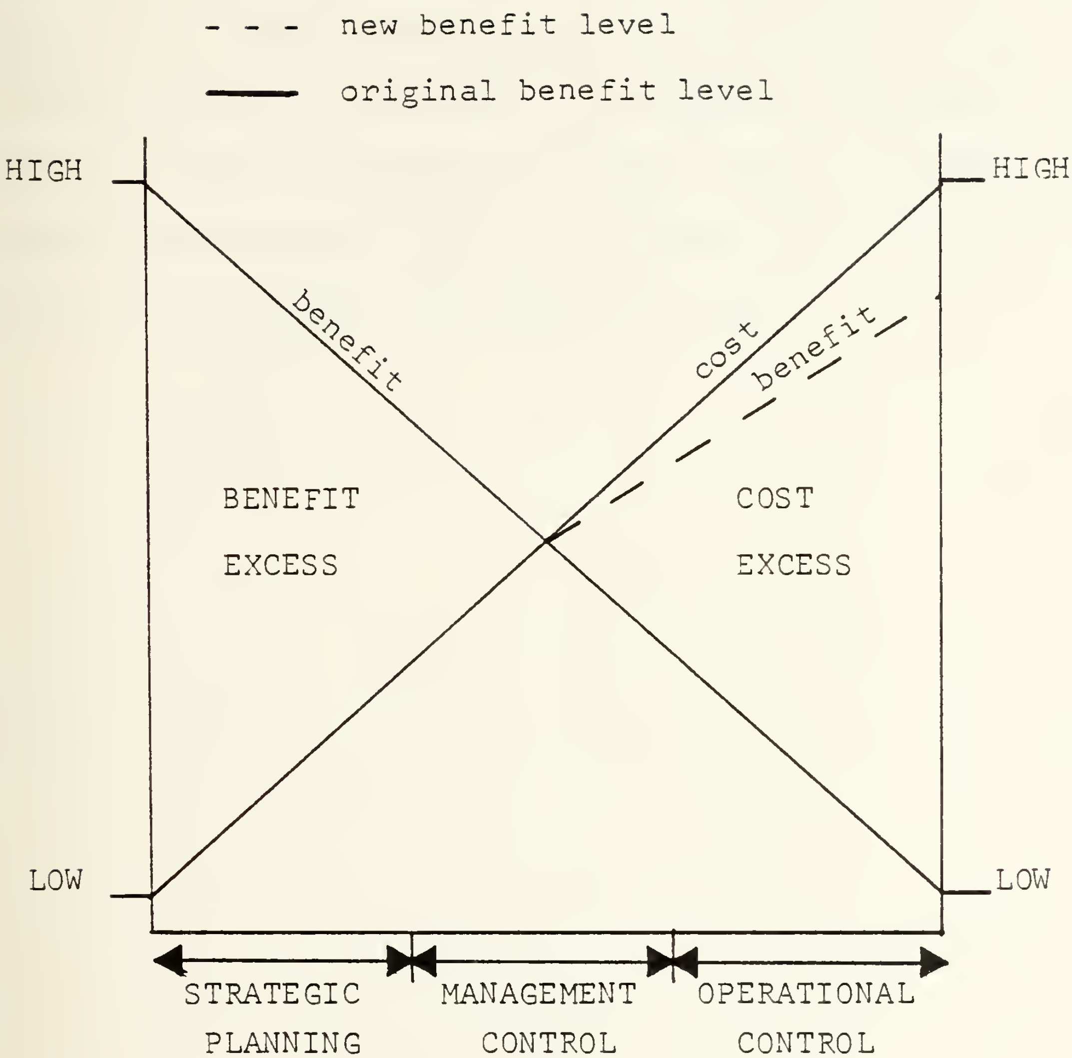
TOTAL COST EXCESS

Figure 6



INCREASING TOTAL BENEFIT

Figure 7



INCREASING BENEFIT AT A SPECIFIC LEVEL

Figure 8

Certainly the situation represented in Figure 5 presents an attractive atmosphere for a favorable MIS project decision. The real problem results from the fact that with the focus of cost excess at the operational control level, the quality of the organization information resource is threatened. Much of the benefit expected from implementation of the MIS project is based on assumptions concerning the quality of that information resource. This localized cost excess situation may, in fact, undermine the very foundation of the organization's information system.

IV. APPLYING THE MIS FRAMEWORK

A. SHIPBOARD NON-TACTICAL ADP PROGRAM

This section will discuss the proposed implmementation of a non-tactical data processing system aboard U.S. Navy ships. The program is called the Shipboard Non-tactical ADP program or SNAP and the specific shipboard application to be discussed is known as SNAP II. The integrated functional description for SNAP II describes this system as a shipboard MIS [Ref. 11: p. 2-1]. SNAP II has been conceived in partial response to Chief of Naval Operations Objective Number 5, which is: "To reduce the administrative burden on the fleets." [Ref. 11: p. 2-2]

The intent of SNAP II is to automate certain manual functions performed in support of formal Navy adminstrative programs or procedures. The initial implementation of SNAP II system will support various aspects of the Navy's Material Maintenance Management (3M) system, supply support and personnel administration. Hardware and standard application software will be provided to each user ship in conjunction with an as yet unspecified level of training and conversion support. An important feature of the justification for expenditures in support of SNAP II is that no additional shipboard personnel will be specifically required to operate and maintain the shipboard system.

The initial discussion in this section will address several preliminary areas before proceeding to an alaysis of the proposed shipboard MIS with relation to the framework developed in Sections II and III. These preliminary areas involve the following questions:

(i) How does the shipboard organization relate to Anthony's three level organizational framework?

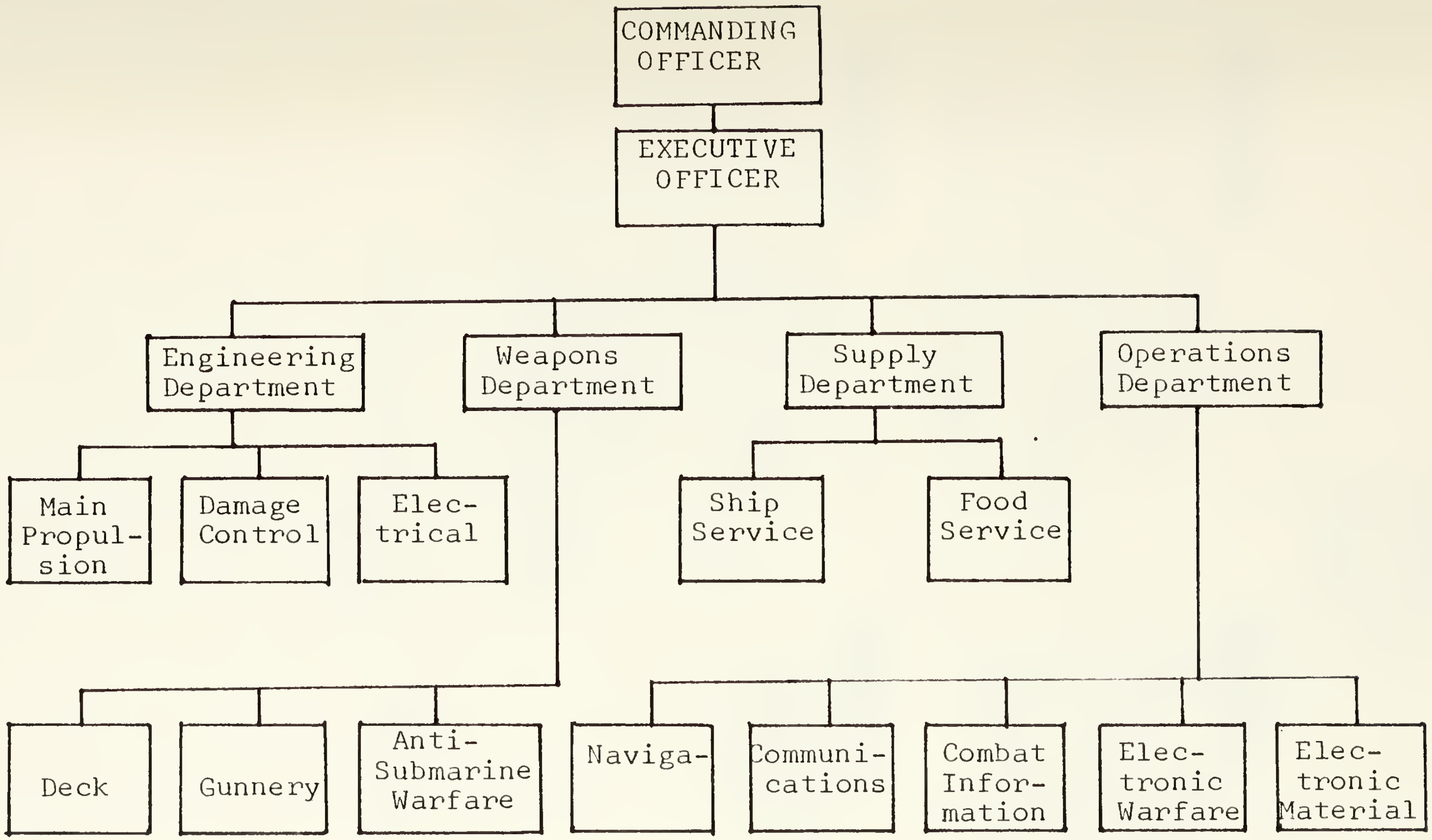
(ii) Is SNAP II, as conceived, a shipboard management information system?

1. Shipboard Organization

A commissioned Navy ship is a unit unique in all the military. Among the over 400 such vessels presently in service, there is a wide range of size, mission, external command hierarchy and everyday activity. The overall Navy command recognizes a Navy ship as an independent activity in many ways.

The head of the shipboard organization, the commanding officer, holds a unique and highly sought postion within the Navy. His authority and responsiblity are wide ranging and, in certain instances, total. The rest of the shipboard organization conforms closely to the classic hierarchical organization structure as illustrated in Figures 9 and 10. It is important to realize that both these figures apply to the same ship. The two figures point out the duality of activity which exists in the shipboard environment.

Figure 9 represents the shipboard organization as related to the ship mission as a combat or combat support platform.



SHIPBOARD OPERATIONAL ORGANIZATION

Figure 9

COMMANDING OFFICER

EXECUTIVE OFFICER

ENGINEERING DEPARTMENT
- Main Propulsion Group
  Boilers Workcenter
  Main Equip. Workcenter
  Auxiliaries Workcenter
- Damage Control Group
  DC Petty Officer Workcenter
  Hull Technician Workcenter
- Electrical Group
  Interior Comm. Workcenter
  Electrical Workcenter

WEAPONS DEPARTMENT
- Deck Group
  Deck Workcenter
- Gunnery Group
  Gunnery Workcenter
  Fire Control Workcenter
- Anti Submarine Warfare Group
  Sonar Workcenter
  ASROC Workcenter
  Torpedo Workcenter

OPERATIONS DEPARTMENT
- Navigation Group
  Navigation Workcenter
- Combat Information Group
  Combat Information Workcenter
- Communications Group
  Radio Workcenter
  Visual Comm Workcenter
- Electronic Warfare Group
  Electronic Warfare Workcenter
- Electronic Maintenance Group
  General Electronics Workcenter
  Radar/Antennas Workcenter

SUPPLY DEPARTMENT
- Supply Support Group
  Supply Support Workcenter
  Food Service Workcenter
  Ship Service Workcenter

SHIPBOARD ADMINISTRATIVE ORGANIZATION

Figure 10

While the example structure shown most closely approximates a combatant such as a destroyer or frigate, any differences from other ships involves only a different emphasis in mission which may increase the importance and size of one department and/or result in a different title for one or more of the departments. The basic relational structure remains the same.

Figure 10 represents the administrative organization aboard ship in conjunction with the routine activities and functions which are performed at various levels and which support the capability of carrying out the primary combat support role. Under the operational structure, the lowest levels of the organization, known as divisions, are an amalgamation of different but related skill areas. The collective function of each division concerns a specific aspect of the ship's operational mission as a combat or combat support platform. Such tasks as servicing and directing main batteries, detecting and tracking targets, and manuvering and navigating the ship are operationally oriented tasks supported by the operational organization in Figure 9.

The administrative structure further divides the division level of the operational organization into subdivisions known as workcenters. In the administrative organizations, the divisions themselves are known as workgroups as shown in Figure 10. The workcenters are distinguished by skill area. Many workcenters contain only one type of skill. Maintenance of shipboard equipment, administrative processing and logistic

support are examples of tasks supported by the administrative organization illustrated in Figure 10.

Both organizational representations are essentially identical down to the department level and in many cases to the division/workgroup level. Two types of operational to administrative relations may exist below these levels. First, many workcenters perform support functions related directly to equipment and systems for which they also have the responsibility of operating in their mission related role. Second, certain workcenters perform a true service support role with regard to systems and equipment which may be operated by other personnel or which support all mission related functions (i.e., electrical power, environmental conditioning, food service, supply support, etc.).

The SNAP II system would be aimed at the administrative structure of the shipboard organization. How and where does this shipboard organization coincide with Robert Anthony's organizational framework as described in Section II? The workcenter level of the shipboard organization corresponds to Anthony's operational control level. The task oriented nature of the workcenter organization strongly supports this classification.

The transition to the management control level would appear to start no lower than the workgroup level and more correctly at or just above the department level. The exact transition is determined by the level in the organization

where the interrelationship between tasks performed by the different departments becomes more important than the actual tasks performed by a specific department. It seems apparent that the commanding officer is to be considered within the management control level at the very least. There remains the potential argument that the commanding officer corresponds more closely to the strategic planning level of Anthony's framework. Gorry and Scott Morton's adaptation of Anthony's framework [Ref. 12] provides some convenient measures against which to consider the applicablity of the strategic planning level designation to the shipboard organization.

Among several factors they use to differentiate Anthony's three levels, one stands out clearly in support of considering the strategic planning level as external to the shipboard organization. The time horizon variable applicable to the commanding officer of a ship would not appear to compare with that which Gorry and Scott Morton use when discussing strategic planning. Ship commanding officers are assigned to their position for a fixed tour length, approximately two years. This time period is known by all concerned and is driven by the need to provide a command opportunity for as many qualified officers as possible while still allowing a significant period within which an individual can demonstrate his ability to perform. Much of the shipboard resources, both in terms of funds and personnel, are available to the commanding officer for periods ranging from one year to 18 months. While

the decisions that a commanding officer makes can have long range impact, the primary decision inputs such as fiscal year budge constraints, junior officer rotation cycles and others, dictate a shorter term planning horizon.

A commanding officer has little input in determining the level of resources provided to his ship. His responsibility, instead, is focused on the efficient utilization of the resources provided. This, too, supports placing the commanding officer within the management control level of Anthony's framework according to Gorry and Scott Morton's measures.

This does not mean that both Anthony's framework and the MIS framework developed in Section II have no meaning in the shipboard environment. What it does mean is that in order to utilize these frameworks it is necessary to view the shipboard organization as part of a larger organization rather than as a discrete, independent organizational entity.

2. SNAP II as an MIS

Based on the preceding section it can be seen that the strategic planning/management control level transition point is external to the shipboard organization. Therefore, a so-called shipboard MIS should be viewed as a segment of a larger organizational information system, It is not important for the purposes of this discussion to further identify the exact transition point. It is crucial that the dependent non-discrete organizational postion of the shipboard organization be recognized.

The previous section has, in fact, answered the question about the designation of a SNAP II system as a shipboard MIS. The SNAP II system is part of a larger organizational information system. The information resource, to which a SNAP II system provides input and access, is not unique to a specific ship and can be accessed by organizational units external to the shipboard organization. To better understand the role of a SNAP II system within a larger system, some specific activities intended for the initial SNAP II implmentation must be examined. The maintenance portion of the initial SNAP II configuration will be used in this example.

It is currently intended that the SNAP II system will automate the shipboard entry and update of maintenance reporting and documentation under the maintenance data system (MDS). At the present time, all such documentation is initially created manually by shipboard maintenance personnel usually at the work center level. Individual maintenance documents form the significant portion of a shipboard maintenance data base known as the Current Ships' Maintenance Project (CSMP). There is some existing computer support for the manual shipboard system. This support is provided by external activities and involves keyed entry of the manual shipboard documents into a larger maintenance data base which includes many ships. Each ship receives automated printouts of the portions of this larger data base which pertains. These printouts are provided on a periodic basis in order that the ship can validate the data and ensure all appropriate entries have been made.

Many organizations, external to the ship, make use of the all inclusive data base for the collation, correlation, data extraction of historical maintenance history. This information has application to those Navy organizational levels concerned with determining the effectiveness and efficiency of operational equipment, operational support equipment and the level of maintenance and logistic support required for these equipments. Prediction of failure rates, mean time to repair, relations between on-hand parts inventories and specific parts requirements and many other measures are derived in some part from the information resource developed through the manual preparation of shipboard documents. The SNAP II system proposes use of computer supported preparation of shipboard documents through interactive use of a cathode ray tube (CRT) terminal located in the individual workcenters. The system would prompt the users through document preparation, provide automatic input of certain universal information (i.e., ship name, identification codes, etc.), conduct validity checks on user entered data and enter the data into the shipboard data base for access, modification or other purposes as necessary. The current data base will be provided to appropriate external activities for update of the overall maintenance data base. The SNAP II system will also provide for interface of the shipboard maintenance data base with other shipboard data bases; most importantly, the supply data base. In this way, the status of supply support for specific

maintenance actions can be determined by maintenance personnel. The supply data base is also updated in terms of the parts requirements for specific maintenance actions. It is expected that this type of shipboard interface will improve the management of maintenance aboard ship. The maintenance subsystem of SNAP II is also expected to provide more accurate, timely and complete maintenance data and reduce the maintenance related administrative burden on shipboard personnel.

The implementation of the SNAP II system requires a significant change in the functional activities of the shipboard administrative organization. In the maintenance subsystem, the change involves the shift of the data entry point to the workcenter/workgroup level. This is the same level which was previously shown to be most closely related to the operational control level of the organizational framework.

In a 1973 article, Cyrus Gibson and Richard Nolan postulated various stages in the growth of data processing capability within an organization [Ref. 13]. This hypothesis was based on actual studies of a number of organizations. Nolan provided measures by which an organizations location within one of the stages of DP growth could be estimated. The importance of this information concerns the ability to make appropriate decisions effecting future organizational DP growth and maturation. In general, the hypothesis states that early DP capabilities involve the creation of an organization information resource and proceeds in an evolutionary way to more

specific and higher level uses of this resource within the organization.

It would appear that the Navy organizational information system of which the shipboard organization is a part has followed an evolutionary course opposite of that postulated by Nolan. The strategic planning and management control levels of the Navy information system have had computer support for a number of years but have been using that capability to draw on an information resource which is initially created through completely manual procedures. The specific form of these manual procedures are significantly dictated by the information requirements of the external activities' computer-based information handling systems. The design and implementation of a computer-based shipboard system will also be largely defined by the configuration and requirements of the existing external system.

The effects of such a reversed system evolution are difficult to predict. There may be no detriment to the implementation of the SNAP II system. It is important, however, for those tasked with the design and installation of SNAP II to understand that a certain degree of flexibility of choice has been eliminated by the apparent reversal of the evolutionary cycle of the overall information system of which SNAP II is a part.

B. COST/BENEFIT EQUILIBRIUM IN THE SNAP II SYSTEM

The Automated Data Systems (ADS) Development plan for SNAP II [Ref. 14] was one of the documents prepared during the program justification phase of the SNAP II program. It contains a very useful summary of the cost/benefit analysis performed in conjunction with the SNAP II Project. The document cites several pilot studies done prior to 1979 under the aegis of several different projects which preceded SNAP II. It lists a dollar cost breakdown of SNAP II requirements [Ref. 14: p. 1-8]. These costs refer solely to hardware, software and associated equipment procurement, operation and maintenance. The benefits anticipated from the implementation of SNAP II are broken down by individual subsystems. The benefits are not dollar quantified [Ref. 14: pp 8-1,8-9]. The only attempt at benefit quantification involves estimates of time savings to be realized by automation of specific shipboard administrative tasks. These estimates are based on the previous pilot studies using individual task support modules of a SNAP II like system aboard test platforms for varying periods of time. There is no discussion as to the similarity of the automated procedures used during these tests to the automated procedures proposed for SNAP II other than that they involve the same subsystem tasks. There is a substantial time savings shown for the use of an automated support system over a strictly manual system. The manhour savings shown by these tabular comparisons do not equate to a potential reduction in shipboard personnel

levels. The savings is expected to be realized in ability to redirect previously committed manhours to other shipboard tasks.

The subject of soft costs or similar impacts of SNAP II implementation is never discussed. All mention of changes which will effect the shipboard organization are couched in benefit terms. These benefits, for the most part, fall in the category of increased accuracy, timeliness and completeness of information. "...the primary value of ADP systems is the aggregation of data into useful information for the shipboard manager which can be used for the timely solution of complex problems." [Ref. 14: p. 1-3] The aggregation of data mentioned in the SNAP II documentation would appear to indicate the type of information handling activity previously classified as information transformation and identified with the management control level of the MIS framework. The benefit associated with this information capability, provided by SNAP II, requires no significant change in the functional activity of the shipboard manager.

Those benefits which can be ascribed to the operational control level of the shipboard organization, by the SNAP II designers, appear to be based on several implicit assumptions. Continuing the maintenance subsystem example, these assumptions become clearer. First, the workcenter individual, utilizing the system for entry of a required maintenance action, benefits from the reduced time required for completion of this

task. The reduced administrative time allows this individual to apply additional effort to other tasks, hopefully more operationally oriented. This may, in fact, result in benefit to the overall organization but it is difficult to support the notion that this benefit is of importance to the operational control level individual. Higher level shipboard managers will actually derive most of this benefit in terms of increased flexibility and capacity to schedule operationally oriented tasks. The operational control level personnel will merely substitute a new task for an old one and, in addition will be available for additional duties. That such personnel will view this as a benefit is not entirely obvious.

The second underlying assumption has to do with the frame of reference used to derive the time savings figures anticipated from use of a tutorially prompted data entry system to replace the manual preparation of a maintenance document. Manual preparation of this type of form currently requires a certain level of reference search prior to preparation. The reference material required to be searched can be extensive and so the ability to conduct such a search through use of an interactive terminal would be very helpful to the individual concerned. However, the extensive nature of this documentation also presents a significant problem to the designer of an automated system. Continuous on-line availability of all possible reference documentation to support potential maintenance actions would require an enormous storage capacity. If

the entire data base is not to be continuously on-line then completion of the data entry task may require determining which segment of the data base is required and operator intervention in order to mount the proper segment. This situation also presents the possiblity of competition among users for different segments of the required data base.

The third assumption concerns the level of key stroke speed and reading comprehension variances among potential system users. Many of the times used for completion of tasks using the automated system were derived from narrowly based studies which used a limited number of personnel. The similarity between these test groups and the potential shipboard user population was not discussed in the documentation which calculates potential time savings using a SNAP II type of task support system. All aspects of manual data entry must be considered when determining the time savings which result from automation of the task. That this was done is not clear from the references.

The final assumption is, perhaps, the most troublesome. One aspect of the maintenance data system is a very high document error rate, as much as 40 percent in some reports. These errors result from poor or incomplete preparation of the required maintenance documents. Erroneous documents are rejected at the point of initial submission by external maintenance managers and are not entered into the automated maintenance data base. These rejected documents must be corrected

by shipboard personnel and resubmitted. This time-consuming process often impacts the levels of outside maintenance support provided to the individual workcenter involved. This is a frustrating and demotivating situation for many shipboard personnel especially if it is perceived, however incorrectly, that the errors resulted from inaccurate supporting documentation provided to the workcenter. The SNAP II justification documentation anticipates a greater than 50 percent reduction in this type of error [Ref. 14: p. 8-3]. This estimate is based on the availability of automatic lookup of certain required data elements and validity/error rejection at point of entry. The SNAP II implementation does not propose a pre-installation update and validation of the shipboard configuration and supporting documentation. Merely indentifying errors, without forcing correction would not result in the initial error reduction anticipated by SNAP II designers, although the desired reduction in errors could eventually be achieved.

Regardless of the timing of the attainment of reduced error rates, a reduction in errors is assumed to be of benefit to the shipboard organization due to the increased level of external maintenance assistance resulting from the more timely submission of error free maintenance requests. This requires that there be a capability for increased external maintenance support. A 1978 study of the maintenance system in San Diego reported that of those maintenance requests which passed the initial error screening, 42 percent were subsequently rejected

or cancelled. Of those, 73 percent were rejected due to a lack of maintenance capacity or capability on the part of outside maintenance activities [Ref. 15: p. 20].

There is no doubt that some of the anticipated results of the implementation of SNAP II would provide benefit, notwithstanding the problems of predicting the amount of such benefit. The SNAP II designers consider the predicted benefits to be focused at the shipboard organization. As discussed, much of the benefit actually accrues at organizational levels external to the ship. This could result in some secondary benefits to the ship but such a connection would be difficult to identify and be significantly displaced in time from the occurrence of the related costs so as to further disguise the connection. Even those benefits which do accrue to the ship apply most often to the management control level of the shipboard level. It has been shown that management control does not correspond to any shipboard level below that of a department. The cost aspects of the SNAP II system, however, are most concentrated at levels below the department, i.e., the operational control level.

C. ENSURING SNAP II COST/BENEFIT EQUILIBRIUM

Based on the previous discussion, it seems likely that the implementation of a SNAP II like system aboard a Navy ship would result in a cost excess situation at the operational control level of the shipboard organization. It is encumbent on the system designers to make an effort to alleviate this

condition in order to facilitate a successful implementation of the system and ensure that anticipated benefits are realized. These efforts can be applied during both the system design and system installation phases of the project.

1. Reducing Cost Impact During Design

The level of soft cost is a difficult variable to manipulate in the design phase. As has been shown, SNAP II is a segment of a larger organizational information system. No significant overall organizational modifications are anticipated as part of the SNAP II project. Many of the SNAP II procedural activities are based on existing regulations and requirements. The objectives of the SNAP II system must conform to these existing boundaries. The required upward compatibility of the SNAP II system with the other segments of the overall information system will dictate specific formats and entry methods for SNAP II users.

This is not to say that cost reduction cannot be achieved through careful design. To do this requires a complete understanding of what formal requirements must be met along with the formal and informal shipboard methods currently used to meet these requirements.

Some basic considerations for cost reduction features of a SNAP II design are:

a. Less Arbitrary Error Identification

Design features which attempt to meet the increased accuracy objective must be evolutionary. No assumptions that

entirely correct information is available to system user should be considered for initial system design. A more realistic objective for initial system design would be identification of sources of incorrect or invalid data entry. Error trapping or validity checking routines, which absolutely prevent further system use for the current task, should be avoided. Exception listings/error flagging routines would increase the users' perception of a 'friendly' system while still providing the substantial benefit of error source identification. (NOTE: The above procedure illustrates the reduction of overall benefit which can occur when attempting to reduce a cost excess situation by manipulating the cost variable. This topic was discussed in Section III.)

b. Avoiding User Competition for System Resources

Design features should attemp to avoid user competition for system services or data. Source data should be sufficiently and uniquely segmented so as to allow multiple concurrent user access to required source or reference data. This segmentation involves both the software design and the hardware configuration. For example, the capability to copy entire segments of the master data base into local 'scratch pad' storage for use during an entire user interaction would decrease the competition/contention situation which can give an 'unfriendly' perception of the system.

c. Maintain System Availability

System configuration design must provide for essentially zero probablity of complete system unavailability.

The type of functions to be performed by the SNAP II system cannot be entirely halted in the case of system failure. Designers may tend to rely on manual procedures to provide system backup and functional continuance during system interruption. The extent of manual backup such as routine hardcopy production of transactions to date and significant manual entry of accumulated data after system restoration, can quickly reduce the time savings benefit expected from the system if system availability is low. Hardware redundancy, such as might be provided by independent but linked microcomputer-based work stations, can allow a high level of system hardware availability when compared to a single processor system. The probability that some system capability will be available at any time with a multiple microprocessor system, is very high since there is no single component or assembly which renders the entire system inoperative. A combination system which uses microprocessor-based work stations with attached storage devices, such as floppy disk drives, for front end data entry to a larger main processor could also be used. The transportability of both hardware and data storage media in a microcomputer system provides significant flexibility to the user by allowing him to maintain system access despite either anticipated or unanticipated interruptions at his primary work station. The larger processor provides the necessary capability to maintain the entire data base and coordinate the networking of the peripheral work stations. Should the main

processor be unavailable, the individual work stations retain some data entry and retrieval capability. After restoration of the main processor, update can be accomplished efficiently and without significant user inconvenience.

2. <u>Increasing Benefits Through Design</u>

In Section III, reducing costs in an effort to alleviate a cost excess situation was discussed as one of two ways to approach the problem. Increasing benefits is another possible method. These marginal benefits can be focused at one specific level of the organization; hopefully, that level experiencing the cost excess. Alternatively, it may be possible to take action which raises the general benefit level of the whole organization. Examples of specific benefit increasing actions which apply to the SNAP II system may include:

a. Automation of Alternative Subsystems

Automation of manually based subsystems with greater realizable benefit to the shipboard organization should be considered in addition to those planned for the initial SNAP II configuration. Automation of the Planned Maintenance System (PMS), for example, may serve to facilitate initial user acceptance of the entire system. The PMS program directly involves all levels of the shipboard organization. The information base for PMS has less external interface than other subsystems currently planned for the initial SNAP II configuration. Those external contacts which do exist act more in support of the shipboard PMS program rather than relying on the shipboard

organization for support of an external system. For the most part, any externally required information related to the PMS program, is reported through MDS procedures. An automated PMS facility would allow the more efficient flow of control information concerning the scheduling and performance of minimum levels of maintenance for operational and operational support equipment. The increased benefit to be gained by the operational control level, from automating PMS, would be as a result of the facilitated access and use of this control information by task-oriented individuals. For example, an automated PMS task support system could provide a maintenace man with a single source of information concerning required tools, consumables, special precautions and parts needed to perform a required maintenance action. In fact, the automated scheduling of this specific maintenance activity could lead to an early identification of support material which is not currently available and could maintain a delivery status of this material after automatically producing a requisition. In this way, the individual charged with the performance of a maintenance action will be able to anticipate problems associated with completing the action as scheduled and take appropriate and timely action to reschedule the maintenance. The benefit of the more timely, complete, and convenient information is more directly focused at the operational control level in this instance than it was in the MDS segment of the SNAP II system previously discussed.

b. General User Support Features

Alternative forms of support which have intrinsic value to individuals at specific organizational levels can increase the favorable perception of the automated system by the user. Computer-aided instruction modules for professional advancement, general education advancement (high school equivalency, etc.) and basic shipboard or military indoctrination could serve to increase the overall perceived usefulness of the automated system at the level which is experiencing a cost excess situation. Even the purely recreational capabilities of the automated system including video games should not be overlooked as a potential source of user satisfaction.

In general, any design aspects which facilitate user interaction with the overall system on a voluntary basis and result in real or perceived benefit to the user while still supporting the primary program objectives, should be viewed as a potential method in ensuring a total organization cost/benefit equilibrium.

3. Reducing Cost During Installation

Installation considerations have been divided into four categories. The most common aspect of these considerations has to do with lessening those initial installation impacts which may translate into user dissatisfaction and contribute to a localized cost excess situation at individual organizational levels. The four categories are:

- Installation timing
- System training
- System maintenance
- System operation

a. Installation Timing

During transition from the manual to the automated system, users cannot be expected to be idle and available only for system installation support tasks. As was pointed out the dual shipboard organization is imposed on a single group of individuals. These individuals have extensive responsibilities and duties placed on them under both organization structures. Transition activities will be significant and require the complete attention of those involved. It would be convenient to assume that no other requirements can or will compete for user attention during transition but this is not a realistic assumption.

System installation schedules must take into account the operational status and overall schedule parameters of each individual unit. Installation should be officially scheduled through the operational and organizational hierarchy appropriate to the unit. Specific levels of shipboard involvement should be specified and promulgated for all concerned organizational levels to be aware of in advance. In addition, installation 'lessons learned' acquired from previous installations must be quickly assimilated into the installation process and scheduling criteria for remaining installations.

External teams which provide specialized assistance, including routine clerical functions, and which can lessen some of the installation burden on user personnel, would provide more flexibility to schedulers in selecting specific installation time periods.

b. System Training

The SNAP II system objective which provides that no additional, specifically trained operator or maintenance personnel be required by the system, imposes an implicit requirement that well-structured, comprehensive training be provided to existing personnel. Most important is the training of shipboard personnel who will, themselves, be trainers. These individuals will also serve as system advocates during the initial phases of system use and as such must not only have a complete understanding of the system but also possess the personal tools with which to pass on that understanding.

The wide use of a system like SNAP II, throughout the Navy, would also dictate that some general introductory or reinforcement training be provided in any Navy educational effort which concerns functional activities covered by the SNAP II system and personnel who are potential SNAP II users.

Assist teams, available on user request, should be established to respond as necessary to support efficient operation of the SNAP II system. It is important that these teams be for user support only and not a means for higher

authority to investigate a specific units' performance with regard to SNAP II interaction.

c. System Maintenance

The maintenance of a SNAP II system involves two distinct areas, hardware maintenance/reliability and software update.

(1) Hardware Maintenance/Reliability. Many system features relating to hardware maintenance and reliability were discussed under system design considerations. Given the restriction against additional, specifically trained maintenance personnel, the ease and timeliness of required maintenance actions must be supported by well prepared documentation and sufficient levels of spare components. Part kits for high failure rate elements and entire assembly spares for critical components must be available to the user organization at the time of installation. Historical failure rates should be used to dynamically reconfigure onboard spares from an original worst case scenario support level. This method is preferred to a most optimistic case procedure which would require gradual buildup of onboard spares after the fact. Low levels of initial hardware availability will hamper all other efforts aimed at ensuring initial system acceptance by users.

(2) Software/Data Base Update. The nature of the activities supported by the SNAP II system will require periodic and often significant updates to those portions of

the SNAP II data base provided by external activities. Price changes, stock and part number changes, updated maintenance requirements and many others will require update of the data base and software on a regular basis. These updates must be able to be accomplished by users without resulting in a major impact on existing user data bases. When such impact is unavoidable, those necessary changes to the user data base should be specifically identified as part of the update process. For example, a part number change should, after entry, cause all outstanding requisitions and maintenance actions affected to be identified and supporting documentation prepared as necessary.

d. System Operation

The SNAP II system has the potential to provide more convenient access to shipboard information by external activities. Those portions of the overall shipboard information resource required to be available to external activities are similar to that which are currently available under the manual based system. Additional access by external activities should be discouraged. A system viewed by the shipboard organization as a 'hole in the tent' for external activities will result in significant user dissatisfaction and a generally unfavorable perception of the personal usefulness of the system. This type of situation emphasizes the need for those charged with the development of SNAP II to view the target shipboard organization as part of a larger organization when determining system environment and capabilities.

D. SUMMARY/RECOMMENDATIONS

SNAP II is a potentially valuable addition to the existing capabilities of the U.S. Navy non-tactical information system. The quality of the underlying information resource, upon which the Navy MIS is built, will be directly affected by the way in which SNAP II is merged with the current information system. At the present time, the apparent failure on the part of SNAP II advocates to recognize the dependent position of SNAP II within the total organization framework threatens the success of SNAP II introduction. A SNAP II disaster places even the current level of benefit, derived from the existing Navy MIS, in serious jeopardy.

In no SNAP II document is favorable user perception a stated objective in itself. The current approach limits the benefits, which users may derive, to those which result within the specific SNAP II subsystems, such as the maintenance subsystem example used in this section. As was discussed, it is often the case that the anticipated benefit does not apply to the user for whom it is and should be intended. By specifying a favorable user perception objective, the SNAP II designers are not constrained by boundaries of the existing subsystems. This concept may be best implemented by introducing a subsystem known as shipboard support which specifically addresses the user perception objective. Within this subsystem, the shipboard organization would be provided the capability and flexibility to utilize the basic SNAP II system

features to develop local, unique applications. This subsystem would not interfere with the other, more externally oriented, subsystems but would support the objectives of these subsystems by increasing favorable user perception of the entire system.

SNAP II is not a true shipboard management information system. However, using the capabilities provided by a shipboard support subsystem, a valuable tool for use in the management of shipboard information would be gained.

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